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ABSTRACT

This paper discusses the types of readiness that are necessary for learning in science and how to assess them. Subject matter readiness refers to what students bring in terms of facts, concepts, generalizations, and principles to the new science lesson. Evaluating many aspects of student background, such as prior instruction, helps in the evaluation of this aspect of readiness. Attitudinal readiness is another important type. Good attitudes toward the curriculum help the student achieve the objectives of the curriculum. Instructional readiness refers to the preparation of the student and the level of complexity of the curriculum. Students also need maturational readiness, with development appropriate to the material being taught. Contextual readiness refers to students' perceptions of ways of using what has been learned in science. All of these types of readiness are necessary for optimum learning. Some suggestions are given for assessing each of these forms of readiness. (Contains 11 references.) (SLD)

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Assessing Readiness for Learning in Science

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ASSESSING READINESS FOR LEARNING IN SCIENCE

Much is written about and speeches given on readiness for learning. Science, as a curriculum area, needs to emphasize students being ready for learning so that they may benefit more optimally from each lesson and unit of study. Readiness is often presented by science educators as consisting of a single concept. And yet, there are several kinds of readiness that teachers need to stress so that students individually learn as much as possible. Which categories of readiness should then be emphasized in the science curriculum?

Subject Matter Readiness

Subject matter readiness stresses what students bring in terms of science facts, concepts, generalizations and principles to the new lesson or unit of study to be implemented. Students individually vary considerably in any classroom, be they homogeneously or heterogeneously grouped, as to how much science subject matter is brought to bear upon what is to be studied. Factors to be considered in science subject matter possessed by students in class include the following:

1. the quality of the science curriculum in a kindergarten-grade twelve sequence.
2. parental interest in the offspring in terms of encouraging school achievement in science.
3. television programs, such as The Discovery Channel, which foster learner fascination with science topics.
4. reading materials, such as library books and encyclopedias, which contain interesting information on diverse science phenomenon.
5. parents who read much content on science and this information becomes a part of the conversation emphasized in the home setting.
6. the public library becomes a source for checking out science materials to be read at home by the student.
7. science computer software stressing tutorial, drill and practice, simulations and gaming used at home and in the school setting.
8. science clubs for students which emphasize an after school enrichment program.
9. trips taken by parents with their children to zoos, science museums, and places of interest and purpose involving science subject matter.
10. home work, supervised by parents, which extends the school science curriculum (Ediger, 2000, 58-67).

By evaluating the above ten items pertaining to how students may bring much subject matter science to lessons and units taught in school,

the reader notices that it is not only the school, but also the home that assists in provide readiness for learning in the science curriculum. The home and school need to wok together for the good of the student for optimal achievement in science to come into being. Readiness then comes from numerous sources in providing students with a body of science knowledge beneficial, in degrees, to the new unit to be studied. Thus, if students are to study, "The changing Surface of the Earth," they need certain knowledge to benefit from objectives to be achieved.

Attitudinal Readiness

A second kind of readiness needed by students is attitudinal. Good attitudes toward the science curriculum do much to guide students to achieve objectives of instruction. When supervising student teachers in the public schools, the author has noticed a few cases of student negativeness toward learning. These students seemingly posses little interest in science. This hinders achievement. Those having positive attitudes have an inward desire to learn, are motivated to achieve, like science and are curious to learn more, raise fascinating questions during class discussion, and are actively engaged in learning within formal/informal situations. What might the science teacher do to foster quality attitudes toward learning?

1. be well prepared for teaching each lesson. This presents a model to learners that the science curriculum is important! Thus, in the science unit, "The Changing Surface of the Earth," students may experience learning opportunities which fascinate and engage student learning.
2. indicate real enthusiasm for the unit being taught. With proper stress, pitch, juncture, and enunciation in the teacher's voice, students might capture the zeal for achievement in science.
3. integrate science content into other curriculum areas. Students then may perceive the importance of science subject matter.
4. help students use what has been learned in science. Positive attitudes may be developed when students perceive uses for achieving objectives in ongoing lessons and units of study.
5. accept and care for each student so that feelings of belonging and worth may come about. A good self concept is necessary for achievement to take piace (Ediger, 2000, 101-103).

In addition to subject matter objectives in science units, students should also attain attitudinal goals. Positive attitudes toward science should assist the learner to achieve more optimally.

Instructional Readiness

Instructional readiness is crucial for students to benefit from teaching and learning situations. Instruction provided may be too complex and many students then do not comprehend and understand the new science subject matter being presented. Or, the level of complexity is too easy, making for boredom. Quality attitudes fail to develop within students when learnings are too complex or too easy. Thus, new goals to achieve should be challenging and yet achievable by learners.

Learning opportunities should be varied in order to provide for individual differences in achievement among students. Concrete, semi-concrete, and abstract experiences should be the lot of students in the school and classroom setting. Thus, the following, among others, may assist in providing for students of different achievement levels:

1. experiments and demonstrations emphasizing a hands on approach in learning. Each student should be able to see clearly what happens in each science experiment and demonstration.

2. the psychology of teaching and learning being stressed in ongoing lessons and units of study. Thus, learning opportunities should be interesting, purposeful, meaningful, and assist each student to achieve as optimally as possible in science.

3. a hands on approach in learning to achieve relevant goals in science. Students need to be actively involved in planning and implementing a hands on procedure of learning in each science lesson and unit of study. The teacher is a guide and a motivator of student achievement. The use of science equipment, among other materials of instruction, is necessary to find answers to questions raised by learners pertaining to science phenomenon. With active student involvement, readiness is perceived by the learner in moving to higher levels of sequential achievement.

4. further emphasis upon the use of diverse materials of instruction in science lessons and units of study include excursions, use of models and microscopes, video tapes, films, filmstrips, slides, illustrations, diagrams, library books, multiple series basal textbooks, software and computer use, and resource personnel, among others to provide for individual differences in achievement. Generally, in moving from the concrete, to the semi-concrete, and then the abstract assists students to use the previous materials of instruction to provide readiness for more complex subject matter to be achieved.

5. use of inductive learning so that students may be challenged in finding information to relevant questions identified. Learning by discovery is challenging to students! Science content presented deductively also has an important role in student achievement of science objectives. With deductive learning, the teacher presents vital content

to students so that the latter may have needed background information to further pursue solving a problem area. Science needs to be exciting, motivating, and fascinating to learners, not dry, dull, nor uninspiring.

6. individual learning opportunities for those who achieve more with intrapersonal intelligence possessed, whereas cooperative learning is stressed for those benefiting more from interpersonal experiences (See Gardner, 1993).

7. making provision for diverse learning styles (See Dunn and Dunn, 1979). The style of learning being emphasized stresses optimal; possible achievement with increasing readiness involved by the learner to pursue the next objective in the science unit.

8. arranging objectives in science to be achieved in ascending order of complexity. A logical sequence stresses the science teacher ordering the objectives, whereas in a psychological sequence the student sequences his/her own order in attaining stated objectives. A logical sequence has more structure in that the science teacher determines objectives, learning opportunities, and assessment procedures, whereas in a psychological order the student has considerable input into the curriculum, such as selecting library books for a written/oral report. Each preceding objective, in either a logical or psychological sequence, provides readiness for the new objective to pursue.

9. implementing the Zone of Proximal Development Theory (Vygotsky, 1976) whereby students come to class with a certain fund of knowledge. There also are new objectives to be achieved.The gap between what is possessed in science knowledge as compared to what is expected in achieving new objectives represents the Zone of Proximal Development. The science teacher, here, needs to plan how to minimize/eliminate the gap through carefully chosen learning opportunities. The knowledge brought to class provides readiness for the new learnings which will provide appropriate sequence in goal attainment.

10. student interest brought to class versus developing appropriate interests for the new lesson or unit of study. Both are important Hopefully students will have interest in the new unit to be taught. They also will be motivated with appropriate readiness activities to benefit from the upcoming unit of study.

Maturational Readiness

Students need to possess characteristics of being mature to achieve optimally in science. Thus, older students will become increasingly proficient in problem solving, as well as in critical and creative thinking. They also will become increasingly capable of learning form the abstract as compared to concrete experiences only/largely.

These are just a few traits of maturation. Jean Piaget (1950) in the study of students for a fifty year period of time developed a well known theory of maturation: he identified the following stages of rapid learner development:

1. sensorimotor, from birth to two years of age, individuals learn from use of the five senses and kinesthetic experiences. Verbal intelligence is minimal. However, foundational learnings are being developed for later stages of maturation.
2. preoperational stage, from ages two to seven approximately, the learner perceives one variable in ongoing learning opportunities. Thus, immediate appearance of an object represents reality, rather that an object can be viewed from many perspectives. Here, words are being used increasingly in referring to objects in the environment. Hands on approaches in science learning can be emphasized at the developmental level of the student.
3. concrete operations, from seven to twelve years of age, students benefit much from science experiments and demonstrations, among other concrete learning experiences. They are able to use many semi-concrete, and abstract materials of instruction. With the abstract, meaningful reading, writing, speaking, and listening in ongoing science units can be emphasized to achieve objectives of instruction.
4. formal operations, twelve years of age and beyond, students are becoming very capable in thinking abstractly , such as in critical and creative thinking,within science problem solving experiences.

It becomes quite apparent that the science teacher needs to pay careful attention to maturational differences among students. Thus, students do mature at different levels and this must be taken into careful consideration when developing the science curriculum. Piaget's studies in developing a theory of maturation indicates how students change as they go through the public school years. How can science teachers learn about the maturational levels when developing the curriculum? The following are important ways:

1. interviewing students in class. Each interview may be short in duration but should be done at selected intervals. When interviewing students, the ensuing should be taken into consideration: which kinds of learning act ivies are preferred; would they prefer to work individually, in groups, or both; and which kinds of homework opportunities are preferred. Data on maturation may certainly be inferred form the interviews in terms of what students are ready for.
2. observing students carefully in ongoing science activities. Which kinds of learning opportunities are students strongly engaged in? How do students view and benefit from concrete, semi-concrete, and abstract activities? These among other questions may be raised to ascertain maturational readiness among students.

3. conferences with parents. At parent teacher conferences, a discussion may center around the changing interests of learners due to maturation. Interest is a powerful factor to consider in teaching. Certainly, parents can have a knowledgeable influence on child growth and characteristic to develop a differentiated science curriculum (Ediger, 2000, 23-29).

There is no doubt that the testing movement is strong in the nation. There are state mandated tests, district wide tests, classroom tests, and standardized tests given to students. With all the time and money given to testing (Education Week, September 6, 2000, p.35 #1), the state of Minnesota spent $3 million for having their statewide tests of students machine scored. Many errors were made in the test results; 538 students were mistakenly given failing grades and 54 seniors were initially denied graduation from high school due to erroneous test results. Three million dollars spent on scoring tests for one state could instead buy a lot of teaching materials and renovate outdated buildings. Be that as it is, state mandated tests are important to select segments of people in society. How were these mistakes discovered? A parent asked to see the test results of his 15 year old daughter and noticed mistakes in scoring. Tests and test results should be open to the public in a true sunshine law. With high stakes testing and going by computer scored printouts, many students could have viewed themselves as failure due to being denied diplomas or having failed the state mandated tests. How should accurately scored test results be used by teachers?

Many in society believe that test results "tell it all about student achievement," and yet, tests are written by human beings. This is true if these are standardized or criterion referenced tests (CRTs). Witness New Jersey state test results when the 4th grade language arts test results were so much lower than for the other academic areas. Almost 75% of fourth graders who took the test scored one out of four points, 25% correct on a part of the test, far below the rates in the other exam areas. The headline for the article (Education Week, September 2000, p.35 #2) reads as follows, 'New Jersey Investigating Suspiciously Low 4th Grade Test Scores." Thus, test items may be written, except for guessing, so that all might fail a test. Or the test items may be written at a level where most will pass. The author's beliefs are that test results should be used for diagnosis and remediation. The teacher may look at what was missed by students and use the results as objectives for learner attainment.

Test readiness is also salient. Tests that are too difficult or too easy should not be required to be taken by students. Students should be measured on what they have had a chance to learn, not what is unknown. Thus, a test must be valid. The test then measures what students have had opportunities to learn. Vagueness in written test items

make for guessing situations for students and nothing is measured as to what has been learned.Test items need to be clearly written so that the learner knows what is wanted. If multiple choice items are inherent in the test, then each of the four distracters need to be plausible. Writing test items is an art and a science. It is a gift that few people possess. Reliability is also important in that a student should receive approximately the same score if the test is taken twice in test/retest reliability (Ediger, 2000, 503-505).

Contextual Readiness

Contextual readiness refers to students perceiving ways of using what has been learned in science. In the science unit on The Changing Surface of the Earth, the learner should perceive practical approaches such as the following to conserve soil:

1. planting of grass to prevent/minimize soil erosion.
2. planting trees to slow down the downhill flow of water to preserve the established soil.
3. planting rotating crops in a field so that the same crop is not seeded every year on the same acreage. This prevents insects from multiplying when inhabiting the same acreage with the crops thereon to be eaten.
4. planting insect resistant varieties of seed so that fewer pesticides/herbicides need to be used. Protection of the environment is of utmost importance.
5. planting crops using no till farming. No till farming stresses not using the mould board plow to plow fields after harvesting grain. Using mould board plows causes increased erosion by leaving fields bare during rainy seasons prior to planting time.

Contextual readiness means that students individually can make use of what has been learned. To be able to use that which has been acquired in terms of science subject matter and skills, students need to

1. understand and attach meaning to facts, concepts and generalizations inherent in what is to be applied. There are numerous experiments and demonstrations which may be preformed in the classroom to observe methods of preventing soil erosion (See Ediger, 2000, Chapter Seven)
2. recall content needed in the application process.
3. hypothesize and test each hypothesis within the problematic situation.
4. analyze what is and what is not salient to solve the problem.
5. think creatively of new approaches in saving the natural environment.

Closing

Students need to posses readiness factors for achieving relevant objectives in the science curriculum. If students are not ready, they may not achieve adequately and optimally. The science teacher needs to study students to ensure that subject matter, attitudinal, instructional, maturational, and contextual readiness are in the offing so that each learner may learn as much in science lessons and units of study as possible.

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